UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE SECRETARY—Circular No. 89

THE AGRICULTURAL SITUATION FOR 1918

A SERIES OF STATEMENTS PREPARED UNDER THE DIRECTION OF THE SECRETARY OF AGRICULTURE

PART VI

RICE

PRODUCE MORE RICE FOR CONSUMPTION AND EXPORT

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AMERICANS DO NOT FULLY APPRECIATE RICE.

HERE in the United States it is difficult to realize that there is no other edible product, except perhaps meat, upon which more people in the world are dependent for food than rice, and that we might advantageously consume much greater quantities of this nutritious food and grow the increase in our own rice fields. An increased production and consumption not only would expand a profitable industry, but the eating of more rice in the place of wheat would release a greater quantity of the bread grain for shipment to the Allies.

The average per capita consumption of rice for food in this country is scarcely 6 pounds a year, and most of this is consumed in the Southern States. The high esteem in which rice is held in other countries is indicated by their per capita consumption. Norway and Sweden consume over 9 pounds per capita; Russia over 11 pounds; England, 27 pounds; France, 34 pounds; Italy, over 101 pounds, and Germany more than 93 pounds. But even these European countries do not begin to eat as much rice as Japan and China. There, rice is the most important article of diet. Each man, woman, and child in Japan, on the average, consumes 147 pounds of rice each year, and those in China, 158 pounds. The placing of such dependence upon rice as a staple food certainly proves beyond a doubt that it is highly nutritious; analysis of rice supports this proof. Pound for pound rice is about as nutritious as wheat. Every 100 pounds of cleaned rice contains 87.7 pounds of nutriment, of which 8 pounds are protein, 0.3 pound fat, 79 pounds carbohydrates, and 0.4 pound ash. The analysis of wheat flour shows

that it contains 87.1 pounds of nutriment in each 100 pounds, of which 10.8 pounds are protein, 1.1 pounds fat, 74.8 pounds carbohydrates, and 0.4 pound ash. Thus the total nutriment in rice is a trifle greater than in wheat. Wheat has the advantage in protein and rice in carbohydrates.

Although rice is the great foodstuff of the Orient, it is not used there in making a raised bread. In this country dietitians have made excellent bread by substituting as high as 25 per cent of rice for wheat flour, and have obtained a white yeast bread of excellent flavor.

WHERE RICE IS GROWN IN THE WORLD.

Rice is a tropical cereal, thriving in regions of high temperature and high atmospheric humidity. Its principal areas of production are in the Orient, where it is an important source of food supply. Excluding China, for which accurate statistics on rice production are not available, British India, including Burma, furnishes over 70 per cent of the world's supply of this cereal. Other important rice areas are found in Japan, China, Cochin China, Java, Malay Peninsula, and the Philippine Islands.

Rice is also successfully grown in the temperate zone. Its total production, however, outside of the tropics is comparatively small. It is cultivated in Japan as far north as 42 degrees, and in Italy to the

TABLE 1.—*Production, imports, exports, and estimated supply of cleaned rice for continental United States, 1912-1917.*

Year.	Rice, cleaned.			
	Production.	Year beginning July 1.		Estimated supply. [1]
		Imports for consumption.	Exports of domestic rice.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1912	695,944,400	174,788,425	157,579,225	713,153,600
1913	715,111,100	235,550,907	163,085,360	787,576,647
1914	656,916,700	147,132,948	201,250,833	602,798,815
1915	804,083,300	120,826,350	263,724,810	661,184,840
1916	1,135,027,800	107,381,170	340,809,963	901,599,007
1917 (preliminary)	1,007,722,200			

NOTE.—In this table Hawaii and Porto Rico have been treated as foreign countries, as to exports and imports. All shipments from the United States to these islands are here included in "exports," and whatever rice was shipped in the opposite direction is included in imports. Also, the exports and imports for the customs districts of Hawaii and Porto Rico have been subtracted from the United States totals. The figures in the original reports for paddy (unhulled rice) and "uncleaned" rice have been reduced to terms of cleaned, by multiplying the weight of the paddy by 55 per cent and of the uncleaned rice by 89 per cent.

[1] Not including stocks carried over from one year to the next.

TABLE 2.—*Principal foreign countries to which domestic cleaned rice was exported from the United States, for the years ending June 30, 1914 and 1917.*

Country to which exported.	1917	1914	Country to which exported.	1917	1914
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
France	45,773,745	53,163	Panama	1,959,561	281,516
Argentina	36,887,737	3,000	Uruguay	1,758,226	none
Cuba	21,906,928	11,378,026	Nicaragua	1,529,180	697,612
Dominican Republic	15,476,048	48,750	French West Indies	1,464,544	2,440
Venezuela	9,411,231	25,018	Trinidad and Tobago	1,204,589	5,000
Chile	9,407,693	19,315	British Honduras	1,173,883	104,480
Mexico	7,616,038	1,292,466	Greece	451,460	none
Canada	4,429,111	1,043,648	Belgium	43,100	461,500
Colombia	3,383,644	17,680	Other countries[1]	10,621,608	631,683
Honduras	2,601,727	1,501,742			
Jamaica	2,247,910	800	Total	181,371,560	18,223,264
England	2,023,597	655,425			

[1] Each receiving less than 1,000,000 pounds in either of these years.

latitude of 45 degrees in the Valley of the Po. In the United States the greater part of the acreage is on the prairies of southwestern Louisiana and southeastern Texas, along the Gulf Coast.

The crop is seldom successful where the mean temperature for the growing season of four months is less than 75 degrees. Its largest acreage is in regions where the annual rainfall is 50 inches or over. For rice cultivation the availability of water is very important, as the crop requires continuous irrigation for a period of approximately 90 days. In addition to water supply, level land is also necessary, for without it cheap and successful irrigation is not possible. In portions of the Orient, where rainfall is abundant, rice is grown without irrigation, but under these conditions the normal yields are very small. In the South Atlantic region of the United States rice is often grown for home use in small patches without irrigation where the water table is near the surface.

IMPORTS OF RICE DECREASING AND EXPORTS INCREASING.

During the last two years the production of rice in this country has been at its maximum, between 36,000,000 and 40,000,000 bushels, or, roughly, 1⅕ billion pounds. The consumption of rice in the United States in recent years, as shown under "estimated supply" in Table 1, has been about 90 per cent of the amount produced. The traffic in rice is not fully indicated, however, without mentioning imports of rice, which amounted during the last three years to 147,132,948, 120,826,350, and 107,381,170 pounds respectively, and exports, which totaled 201,250,833, 263,724,810, and 340,000,000 pounds. The United States not only continues to export rice to practically all countries to which it

shipped this food before the war, but exports to a number have increased materially. For instance, exports to France in 1914 amounted to only 53,000 pounds, whereas, for the fiscal year ending June 30, 1917, they totaled 45,773,000 pounds. Exports to England increased from 655,000 pounds in 1914 to 2,023,000 pounds in 1917.

Exports of rice are of two kinds: domestic, or rice produced in the United States; and foreign, or rice imported into this county and then re-exported. Exports of foreign rice in 1917 amounted to 44,356,000 pounds and domestic cleaned rice to 181,371,000 pounds. (See Tables 2 and 3.) Imports of rice have declined steadily for the last three years, while exports have increased much more rapidly than imports have declined. The falling off in the imports of rice into this country during the last few years may be attributed to the fact that before the war we received large quantities of rice from Germany, Holland, and England. This source of supply has been practically cut off. A glance at the tables indicating in detail the exports of foreign and domestic rice will show that the rice produced in the United States is being shipped in increasing quantities to countries to which heretofore we re-exported foreign rice and small amounts of domestic rice. A number of these countries previously imported rice from Europe, but that trade has been practically stopped since the beginning of the war.

TABLE 3.—*Exports of foreign rice from the United States, years ending June 30, 1913-1917.*

Country.	1913	1914	1915	1916	1917
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Argentina			138,478	1,112,796	
Canada	63,367	395,391	75,472	1,197,948	163,395
Costa Rica	780,199	975,047	2,094,279	1,985,885	1,339,566
Cuba	36,489	1,220	2,655,822	18,680,859	11,308,323
Colombia	305,183	127,866	4,886,493	7,685,310	3,337,883
Chile		121,320	510,144	590,785	130,906
British West Indies	277,464	194,210	314,183	662,050	1,620,916
British Oceania (excluding Australia)	1,853	25,976	36,919	101,368	115,899
Dominican Republic	185,541	499,307	8,892,767	7,650,313	6,277,739
Ecuador	5,900	302,818	1,902,764	1,205,873	3,160,804
French Oceania	650,608	763,412	1,442,790	1,726,947	1,544,660
Guatemala	575,288	263,554	699,493	245,344	469,876
Greece			727,789	510,608	
Honduras	523,847	419,090	908,954	899,911	70,594
Haiti	744,254	308,140	756,862	2,454,864	584,103
Mexico	2,141,603	4,460,102	6,970,246	12,009,335	4,490,101
Nicaragua	4,688,922	2,280,816	4,998,757	2,255,095	1,681,923
Netherlands		60,000	1,021,413		
Panama	1,117,774	6,273,158	13,996,296	4,450,322	1,379,715
Peru	75,000	60,255	527,279	370,333	820,783
Venezuela	318,011	173,423	4,791,820	5,365,577	3,631,524
Other countries	189,854	81,926	837,421	633,004	2,227,532
Total	12,681,157	17,787,031	59,186,441	71,794,527	44,356,242

TABLE 4.—*Acreage, yield, and value of rice in the United States, 1915-1917.*

State.	Acreage.			Yield per acre.			Production (000 omitted).			Price per bushel Dec. 1.			Value per acre, basis Dec. 1 price.		
	1917	1916	1915	1917	1916	1915	1917	1916	1915	1917	1916	1915	1917	1916	1915
	Acres.[1]	*Acres.*[1]	*Acres.*[1]	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Cts.*	*Cts.*	*Cts.*	*Dolls.*	*Dolls.*	*Dolls.*
N. C.	300	300	200	26.0	21.0	21.0	8	6	4	195	85	85	50.70	17.85	17.85
S. C...	3,000	3,500	3,700	25.0	14.0	24.3	75	49	90	195	90	90	48.75	12.60	21.87
Geo...	900	800	900	30.0	20.0	29.3	27	16	26	195	87	88	58.50	17.40	25.78
Fla. ..	800	700	500	26.0	25.0	25.0	21	18	12	195	75	75	50.70	18.75	18.75
Mo. ..	400	200	200	45.0	51.0	50.0	18	10	10	190	100	100	85.50	51.00	50.00
Ala...	400	300	300	27.0	25.0	25.0	12	8	8	190	75	75	51.30	18.75	18.75
Miss..	2,100	1,900	1,800	30.0	28.0	25.0	63	53	45	190	80	88	57.00	22.40	22.00
La. ...	500.000	443,300	401,000	36.5	46.0	34.2	18,250	20,392	13,714	190	90	90	69.35	41.40	30.78
Tex...	230,000	235,000	260,000	27.0	45.0	30.5	6,210	10,575	7,930	200	86	89	54.00	38.70	27.14
Ark..	146,200	125,000	100,000	41.0	50.5	48.4	5,994	6,312	4,840	190	96	95	77.90	48.48	45.98
Cal. ..	80,000	58,000	34,000	70.0	59.0	66.7	5,600	3,422	2,268	175	78	90	122.50	46.02	60.03
U. S.	964,100	869,000	802,600	37.6	47.0	36.1	36,278	40,861	28,947	189.4	88.9	90.6	71.28	41.78	32.66

[1] Acreage figures in full (000 not omitted).

AREAS IN THE UNITED STATES.

In this country the crop is grown mainly in five regions. On the tidal deltas of the coastal plain of the Carolinas and Georgia rice has been grown for over 200 years. It was introduced into South Carolina at Charleston in 1694. Until 1861 rice growing in this section was a large and profitable industry, but the crop is of very little agricultural value in these States today.

Rice grows well on the alluvial river bottom lands of Louisiana. It was grown in a limited way in this part of the State before the Civil War, but not on a commercial scale until 1865, when it was demonstrated that rice could be made a profitable crop on the old sugar plantations where labor had become scarce. The water for irrigation is obtained mostly from the Mississippi River by means of siphons. Natural drainage toward the swamps and bayous is usually very good, though artificial means which are seldom costly are sometimes used.

The great rice region of the United States lies in southwestern Louisiana and southeastern Texas, where there are broad, level prairies which are broken here and there by sluggish streams from which the irrigation water is obtained by the use of powerful pumps. These streams are at a much lower level than the fields and serve as natural outlets for drainage. In certain sections of these prairies irrigation water is pumped from deep wells. This region produces over three-fourths of the rice grown in this country. In acreage and production Louisiana ranks first, and Texas second. Of the 964,100 acres of rice grown in the United States in 1917, Louisiana had 500,000, and Texas 230,000. On this acreage, in 1917, Louisiana produced 18,250,000 bushels, and Texas 6,210,000 bushels.

There is a similar, though much smaller, prairie region used for rice in eastern Arkansas, the center of which is Stuttgart, where 146,200

acres were grown in 1917, producing 5,994,000 bushels, or about one-sixth of the total crop of the United States.

The rice industry of California is of recent development. The investigations inaugurated by the Department of Agriculture in the spring of 1909, and continuing three seasons, furnished valuable data on the commercial possibilities of rice culture in California. These investigations were largely responsible for the beginning of the industry. The first commercial crop of rice in California was grown in 1912 on black adobe soil in the Sacramento Valley, near Biggs. The profits from this crop

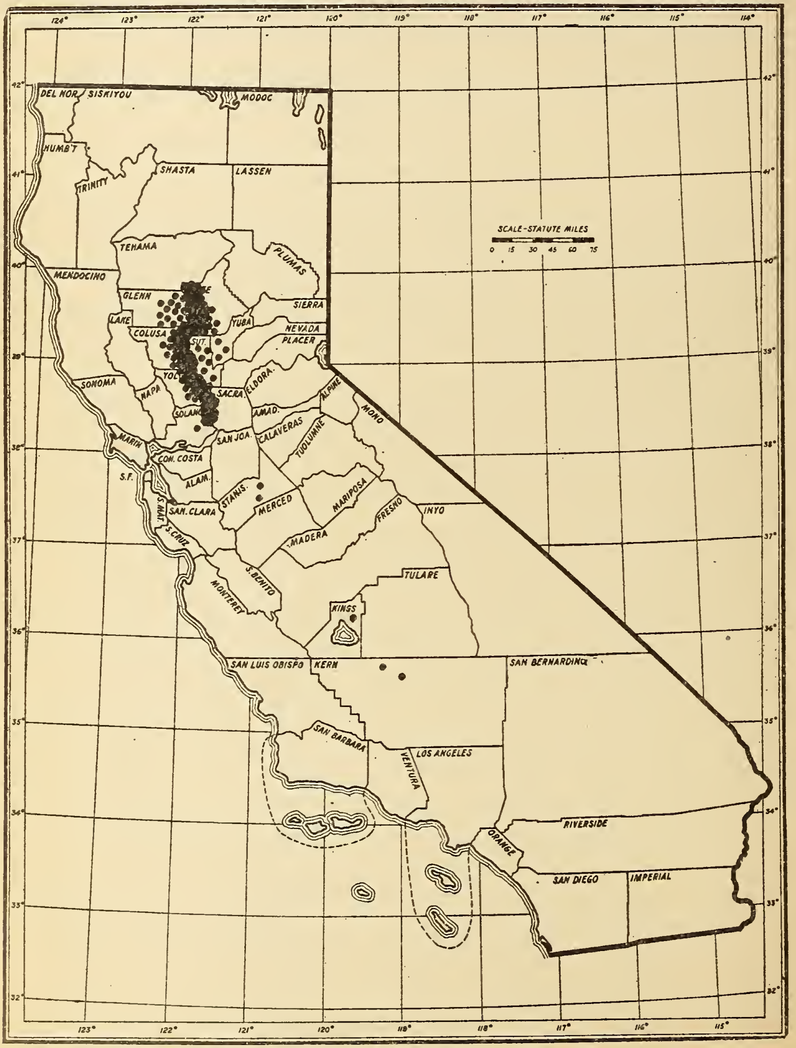

FIG. 1.—CALIFORNIA RICE ACREAGE, 1916. EACH DOT REPRESENTS 500 ACRES.

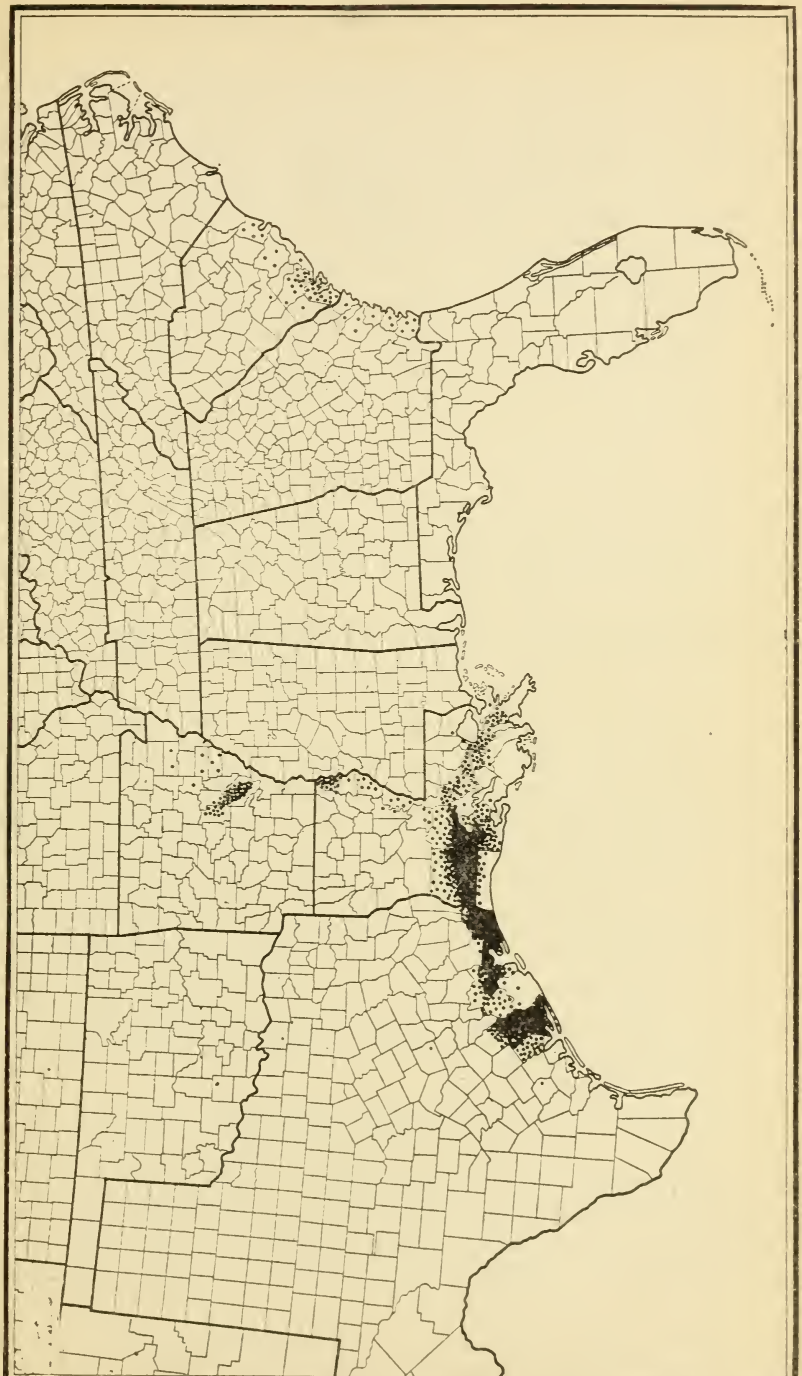

FIG. 2.—UNITED STATES RICE ACREAGE, 1909. EACH DOT REPRESENTS 500 ACRES.

of 1,400 acres were large. The wide publicity given to the net returns resulted in the sowing of 6,000 acres in 1913. The average yield of 3,200 pounds of grain per acre which was produced by the 1913 crop gave so great an impetus to the industry that in 1914 the area sown in rice was increased to 16,000 acres. By 1916 the acreage had increased to 55,300 acres, which produced 3,263,000 bushels of grain. In 1917, California produced 5,600,000 bushels on 80,000 acres, or about one-sixth of the crop grown in this country.

The total rice production in the United States since 1903 has averaged annually 23,582,000 bushels on an average acreage of 687,923 acres. During this period the crop has made an average yield of 33.8 bushels. The largest crop of rice ever produced in this country was in 1916, when 866,000 acres produced 40,702,000 bushels of rice. This large crop was made possible through a combination of a large acreage and the heavy yield per acre of 47 bushels. Last year's crop was sown on the largest acreage ever seeded to rice in this country, 964,100 acres, but the yield per acre was low, 37.6 bushels, compared with that of 1916, which resulted in a total crop of 36,278,000 bushels. (See Table 4.)

WAYS OF INCREASING THE OUTPUT OF RICE IN THE UNITED STATES.

Increasing the Acreage.

So far as climate and soil are concerned, the rice acreage in this country might be increased many fold, since in the States of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, and California, as well as in small areas in Missouri, millions of acres are adapted to the cultivation of rice, while less than 1 million acres, located within a comparatively few States, are now occupied by rice. One of the quickest ways of increasing the crop is to expand the acreage in the areas where rice is already profitably grown. Within recent years the use of modern machinery and tractors in fields in the Southwest and in California has revolutionized the methods of cultivation, made it possible to sow more acres, and to reduce the cost of growing rice.

With the present irrigation systems it is possible to increase the area devoted to rice in Louisiana and Texas from 20 to 25 per cent, and along the Mississippi River even a larger increase could be made. In Arkansas, on account of the high cost of pumping equipment for the wells necessary for irrigation and the scarcity of such material, the rice prairies might be limited to an increase of approximately 10 per cent.

In California, steps could be taken immediately to extend the canal systems and thus nearly double the present 80,000 acres grown in the State.

Increasing the Yield Per Acre.

The yield of rice in the United States during the past 5 years has varied from about 31 to 47 bushels per acre. This variation in yield itself is proof that rice experiences many untoward conditions, some of which, at least, can be controlled. It is the same with rice as with other grains—seed of the proper variety suited to the location and season will return a much better yield than seed chosen at random. Ample varieties suited to the peculiarities of the different rice-growing regions exist, and it is largely a matter of making the proper choice. This is not a time to experiment, however, and the leading heavy-producing variety in the territory probably is the best to seed at this time.

The leading long-grain rice in the United States is the Honduras variety, which is grown in all of the prairie rice regions, but which reaches its maximum yield and quality on the alluvial river bottom lands along the Mississippi in Louisiana. It is an early-maturing rice, requiring a growing season of approximately 130 days. Among the domestic rices it commands the highest price on the cleaned-rice market. This variety should not be grown in California, as attempts there to grow it experimentally have met with failure.

The principal short-grain rices are the Japanese varieties, Shinriki, Wataribune, and Omachi. They are very hardy rices, have a long-growing season and produce large yields. These short-grain rices are well adapted to prairie conditions. In California they are the only varieties that are grown, and in that State they produce their greatest yields. The short-grain rices break less in milling than the long-grain varieties, and for this reason the millers prefer them; but the general trade shows a preference for the long-grain rices.

The Department of Agriculture has developed, by selection, 12 varieties which are being grown in three States. Their yields and quality of grain are superior to the varieties that are now grown commercially. These can be obtained by application to the rice experiment station at Crowley, La., and at Biggs rice field station, Biggs, California.

GENERAL REQUIREMENTS OF THE CROP.

As indicated in the preceding discussion of the localities in which rice is and can be grown profitably, the production of this grain is a specialized, although not a complex, industry. It has several rather exacting requirements, however, which should be understood thoroughly before the crop is grown for the first time, since we can ill afford to direct our energies at this time along unfruitful lines. When agricultural labor is unproductive not only does the farmer lose money, but the consumer has available less food and at a higher price. With this

in mind let us consider some of the prerequisites of proper and profitable irrigation which should receive particular attention at this time.

Rice requires the application of water continuously at a uniform depth for many days, and in order to meet these requirements the land which is selected for this crop should be level and underlain by a subsoil that is impervious to water. The expense of preparing a level tract for irrigation naturally is less than for a rolling one, and the cost of maintenance is also less, because there are fewer levees. The impervious stratum of soil should lie near the surface, for a deep soil requires more water and more time for its submergence than a shallow one. The importance of good drainage cannot be too strongly emphasized. Without it, the field cannot be quickly drained for harvest. Delay in draining a field may cause a heavy loss in yield. It is also necessary in order to prevent water-logging—a condition which unquestionably affects the yield. Clay soils, when easily drained and not too deficient in organic matter, seem well suited to the production of rice. Loamy and even sandy soils produce good crops of rice under ideal conditions of irrigation and drainage.

Rice is more productive on soils of medium to rather heavy texture than on lighter loams and sandy soils. The typical rice soil of Arkansas and southwestern Louisiana is the Crowley silt loam. This soil is a brown or ash-gray loam containing approximately 4 per cent of very fine sand, 69 per cent of silt and 23 per cent of clay. It is noticeably rather compact in structure and has a tendency to puddle if plowed when wet. The subsoil, which lies at an average depth of 16 inches, is a mottled blue and yellow clay that is extremely impervious. Through this clay there is no loss of irrigation water by seepage.

In Texas the soils are of a more tenacious character and are therefore more difficult to cultivate. They lie upon an impervious clay and on an average are no greater in depth than the Crowley silt loam. These soils are very plastic and sticky when wet. Some of them crumble and break down on drying out even when plowed in a very wet condition, while others can not be successfully cultivated unless plowed when the moisture conditions are just right. The latter is particularly true of the soils known as hog wallow land.

The larger part of the rice crop in California is on black adobe soil. This soil contains approximately 50 per cent of clay. In structure it is very close and compact. It is exceedingly tenacious and puttylike when wet. The subsoil, which lies at a depth of approximately 3 feet, is gray in color and is rather impervious to water. There are approximately 200,000 acres of this soil in the Sacramento Valley that may be used for the culture of rice, but other types of clay soils in California have been used for rice with success. Average yields have been obtained on some where the surface of the soil gave indications of high alkali

content. These salts may be present in a relatively small quantity near the immediate surface, and can be easily removed by the irrigation water, which may indicate that with thorough drainage and an ample supply of water for irrigation, rice may be profitably used to reclaim these alkali lands. Rice is apparently more resistant to alkali salts than other cereals.

BETTER IRRIGATION METHODS.

As before indicated, irrigation plays an important part in the production of rice, even on soils of proper composition and which have an impervious subsoil, but even then all irrigation water, especially this year, should be applied properly and without waste so that it may cover the maximum acreage.

The water that is needed for rice production in Louisiana and Texas is obtained mostly from streams and wells. From the streams it is lifted by powerful pumps and distributed by canals which are operated by private companies. These companies furnish the water on a rental basis. The cost of rental ranges from $6 to $9 per acre per season. The water may be supplied for one-fifth of the crop, or it may be furnished for 2 bags of rice averaging 180 pounds each. If land, seed, and water are furnished, a charge of one-half of the crop is made.

Although the major part of the rice acreage in these States is irrigated from canals, the supply of water for at least 150,000 acres is obtained from deep wells. When the deep well is the source of the water supply the well and its outfit are included in the farm equipment. The size and capacity of the pumping outfit depends upon the acreage to be irrigated and the height to which the water must be lifted. The minimum capacity of the pump should not be less than 7½ gallons or 1 cubic foot of water per minute per acre. Some of the less compact soils which are used for rice require at least 10 gallons per minute per acre.

It is a common practice along the Mississippi River where rice is grown to carry the water over the river levee by means of a siphon. When the water level is high in the river the water is easily drawn through siphons, but when it is low the water is pumped from the river to the intake of the siphons on the river side. This method of getting water for rice is very cheap, even when pumping is required.

In California, the irrigation water for rice in the Sacramento Valley is obtained chiefly by gravity, mainly from the Sacramento and Feather Rivers. In the San Joaquin Valley the water is supplied by small streams and deep, flowing wells.

An outfit that will provide at least 7½ gallons or 1 cubic foot of water per minute per acre may not furnish enough water to meet the requirements of rice. A greater capacity is required if the crop is

grown on soils that are looser in texture than clays and silt loams. Irrigation from wells is more expensive than from canals. In Louisiana the average cost of irrigation from wells having a lift of approximately 20 feet is $6.67 per acre per season. The wells in Arkansas have an average lift of 40 feet. The cost of pumping water from them averages $11.61 per acre per season. Deep wells furnish most of the water that is used in irrigating rice in Arkansas.

Level land with a gentle slope is well suited to the irrigation of rice. With such surface features a field can be irrigated economically and drained satisfactorily if the natural outlets are not too small or overtaxed. A rice field must be inclosed by strong levees in order to hold the water that may be put upon it. Since it is also important to maintain a rather uniform depth of water in irrigating rice, the field must be divided into as many subfields or "cuts" as are necessary to obtain this condition.

A competent civil engineer should be employed to locate the levees, especially those that separate the subfields. These levees should be permanent and constructed on contour lines at distances which will hold the water at an average depth of 6 inches. They should be at least 10 feet wide at the base and built up with sloping sides to a height that is just high enough to prevent the water from overflowing into the subfields below. All kinds of farm machinery may easily pass over levees of this character without damaging them. This simplifies field operations, for they make possible the cultivation of an entire field as a unit instead of the separate cultivation of "cuts," which is necessary where high narrow levees are used. They are also of further service as they can be planted to rice and thereby increase the cultivated area. This prevents any waste of land and leaves no uncultivated strips in the field for the growth of weeds. Rice that is produced on these levees is often of a very good quality. The yield from these plants, however, may be lower than from those more favorably located, but the results obtained in the control of weeds alone will justify the practice.

Firm and compact levees, which are necessary to reduce seepage, should be constructed and rebuilt during the winter. When constructed at this time they are more serviceable than when made just before water is applied. It is better to build new levees at least one-third higher than the required height. This will allow for settling and washing. It is cheaper than building up the levees with the shovel after the land has been submerged. The average cost of constructing field levees and laterals is approximately $1.50 per acre. On land where only a few levees are needed the cost may be as low as 20 cents per acre.

The water is admitted to subfields through openings in the levees. These openings should be controlled by wooden gates and not made with a shovel each time water is needed. The gates should consist

of a floor and end pieces to hold a sliding shutter in a vertical position across the opening. The flow of water may be regulated by the shutter, which consists of narrow pieces of wood that may be increased in number or removed as the water is raised or lowered.

The irrigation water is usually first applied when the young plants have reached a height of 6 to 8 inches. The subfields at this time are submerged to a depth of 1 to 2 inches. This depth of water is held for several weeks and is gradually increased until the maximum depth of 5 to 6 inches is obtained. At this stage, the plants have a vegetative growth of at least 2 feet. Throughout the growing season this depth is maintained, fresh water being applied when needed to supply losses from seepage, evaporation and transpiration. Irrigation is seldom used to germinate the seed, except in California, where rains do not usually occur after seeding.

When irrigation is required for germination great care must be used in applying the water; for if water is left on the land too long at this season of the year it is likely to cause the seed to rot. Before the plant comes up, water should not be allowed to remain on the land longer than 24 to 48 hours after each irrigation. After planting, under these conditions, the soil should never be allowed to dry out and the field should be submerged approximately 30 days after the plants have come up.

The amount of water required to make a good crop of rice will depend largely upon how well the outside levees have been constructed and what quantity of water is allowed to flow through the field. To conserve water and to expand the acreage this year levees should be made as seepage-proof as possible, since poorly constructed outside levees are responsible for the loss of much water in this way. The loss is further increased by allowing too much water to flow through the fields in an effort to keep the field water fresh. From data obtained at two of the rice field stations of this Department, 4 to 5 acre-feet of water are required to produce a good crop of rice.

PROPER PREPARATION OF THE SEEDBED INCREASES YIELD.

Late in the fall or in the winter the rice farmer can take steps to increase the yield of rice by plowing his fields to a depth of 5 to 7 inches preparatory to making a good seedbed. This step in rice growing is particularly important at this time when high yields per acre are desired. The plowed land should be well drained so that winter rains will wash out any alkali that may have accumulated in the surface soil and leave the clods in such physical condition that they are easily broken by the disk and harrow in the spring. It is difficult and expensive to prepare land for seeding that has been plowed in winter, unless good drainage has been provided. Land that is plowed in the

spring should be disked and harrowed at once before it has time to dry out. The surface soil of the seedbed should be loose and finely pulverized to a depth of at least two inches. A seedbed of this character retains moisture and increases the chances of good germination and vigorous growth of the young plants without irrigation.

BETTER METHODS OF SEED SELECTION AND SOWING OF SEED.

Equally as important as preparing the seedbed is the selection of the proper variety of well-graded, cleaned and tested seed. Ungraded seed is responsible for many poor stands, and the use of uncleaned seed is one way by which weeds are introduced into a field or their numbers increased. The use of the fanning mill for grading and cleaning rice to be used as seed pays big dividends for the time and money invested in the work. Since seed rice may be exposed to weather conditions at harvest time that may affect its germinating power, it should always be tested for germination. For the test several lots of 100 seeds each should be taken from a composite sample of the seed to be sown. Each lot should be placed separately between blotting papers or Canton flannel and kept moist at a temperature of 70 degrees F. for at least a week. The number of seeds that have strong sprouts should then be counted. The seed that shows low vitality should not be sown, but, if used, the rate of seeding should be higher than that commonly recommended for the variety.

To secure an even distribution of the seed, rice should be sown with a drill. Less seed is used by this method and a more uniform stand is secured than by broadcasting. On a seedbed in good tilth rice is sometimes sown broadcast, but this method requires more seed and labor. A disk drill is ordinarily used, but a shoe drill may give just as good results.

The depth to which seed should be sown depends upon the condition of the seedbed. It should not exceed 2 inches, though a greater depth may be necessary on cloddy lands to cover the seed well. A less depth is desirable on a seedbed with a good moisture content. Shallow seeding, however, is not safe if water is applied to secure germination.

RATE AND TIME OF SEEDING.

Much can be done at seeding time to insure a good stand and a heavy yield of grain in 1918. The Crowley rice station has demonstrated that the largest yields of the Honduras variety can be obtained by sowing with a drill about 80 pounds of seed to the acre. Good results are usually obtained with other commercial short-grained varieties by seeding 65 to 75 pounds per acre. Less seed may be used, however, when the crop is sown late in May, if the seedbed is well prepared, as

better germination is obtained at this time than at an earlier date. Seeding at too low a rate, however, is likely to cause excessive tillering, which will result in irregular ripening and reduced yields. All varieties should be sown in excess of the rates mentioned if sown broadcast on wet land and on a poorly prepared seedbed. Only the best seed should be used, but if it is necessary to sow seed of low vitality the rate of seeding should be greatly increased.

In the prairie section of Louisiana and Texas the greater part of the rice crop is sown from April 1 to May 15. Along the Mississippi River in Louisiana rice is sown generally at a much earlier date. Under normal weather conditions in the prairie section, the Honduras variety when sown during the first week in May matures during the first week in September. The other commercial varieties that are grown in these States, when sown at the same time, mature on an average from 14 to 23 days later. Rice when sown during the first week in May germinates within 9 to 12 days. In earlier seeding, germination may not occur for 14 to 20 days. If sown two weeks later it germinates within 7 days. Seeding as late as June 1 may be an advantage on weedy land when the land is plowed in the winter and is cultivated repeatedly in the spring until the crop is sown. Rice can not be sown with safety as late in Arkansas as on the Gulf Coast. May 1 is approximately the best date for sowing rice in the prairie section of Louisiana and Texas.

In California it requires approximately six months to mature a crop of Wataribune rice, which is the leading commercial variety of the State. The crop should be seeded so that it may be harvested before the autumnal rains begin. The risk of losses from wet weather increases as the harvest period becomes later. In a date-of-seeding test at the Biggs rice field station in which rice was sown every 15 days from April 1 to May 15, inclusive, the early seeding invariably gave the largest yields. The yields decreased from 400 to 500 pounds per acre with each successive later planting. April 1 is recommended as the approximate date for sowing rice in California. It is never safe to seed Wataribune rice in this State after May 1.

USE OF FERTILIZERS TO OBTAIN LARGER YIELDS.

It is not the practice of rice farmers in this country who use fertilizers to apply the so-called complete fertilizers containing three elements of plant food—nitrogen, phosphorus, and potash. The prairie rice soils, as a rule, are deficient in phosphoric acid, but in most of them there is enough potash. The fertilizers that are commonly used contain from 10 to 12 per cent of phosphoric acid and from 2 to 4 per cent of potash. They are applied with a drill at the time of seeding at rates varying from 80 to 250 pounds per acre. With the scarcity and

high price of potash this year very little of it will be used on rice fields. An application of phosphoric acid either in the form of ground raw rock or superphosphate should result in increased yields on soils deficient in phosphorus.

DRAINING THE LAND AND HARVESTING THE CROP.

Rice fields which are not properly drained require much more work at harvest time than those having a number of ditches of sufficient depth and width to drain thoroughly the soil as well as the surface water. The number and location of these ditches will depend upon the surface features of the land under cultivation. The surplus water should be carried away quickly, and this can be done by connecting the field outlets with water courses or artificial channels of sufficient capacity. The latter, however, is an engineering problem requiring community cooperation and is being solved in many localities by the creation of drainage districts.

Irrigation water should be removed promptly from the rice field when the crop is ready to be harvested. Harvest is usually delayed on fields that drain slowly, and this delay may result in losses in grain from shattering. At this time when it is desirable to obtain as great a return as possible for the labor employed, rapid drainage of the field becomes more important than ever. The cost of harvesting on a boggy field is greatly increased on account of additional time and labor required. The field also should be well drained during the winter to prevent water-logging and to aerate the soil. The draining of the land at this time is necessary if a thrifty plant growth is to be obtained during the following growing season.

With the exception of a comparatively small acreage along the Mississippi River and in the South Atlantic States, where the crop is cut with a hand hook, rice is harvested with a twine binder. It should not be left standing until fully ripe, but should be cut promptly when the kernels of the lower part of the head (botanically known as panicles) are not entirely hardened. This stage of maturity is indicated by the position of the heads, which are well turned down. If cut earlier the quality of the rice will be greatly affected by a large percentage of imperfectly formed kernels. If cut later there will be a loss of grain from shattering.

The value of the rice crop depends to a considerable extent upon the thoroughness with which the grain is shocked. If the crop is not shocked in such a manner as to protect it from the sun, the grain is likely to crack, and if not protected from the rain the dampness will affect the proper hardening. Rice that has been carelessly shocked can not produce the maximum yield of head rice when milled. It is this grade of milled rice that commands the highest price on the cleaned-rice market;

therefore, the miller makes his highest bid on the rough rice which, in his opinion, will produce large yields of this grade.

The shocks should be strongly built to withstand the wind, and well capped. The first two bundles of a shock should have the butts firmly set into the stubble and sufficiently apart to be well braced when the heads are brought together. Place around these 8 to 10 bundles so as to form a round shock, making provision at the same time for free circulation of the air. A large bundle should be selected to serve as a cap. Slip its band down to the heads and put it in an upright position with the heads down in contact with the heads of the bundles forming the shock. When it is in this position, open the bundle from the center by bending the straw at the band. Pull down the straw and spread it evenly to make a covering for the heads of the cap bundle and the underlying bundles. When the straw is wet or not entirely ripe it is probably an advantage to use a smaller shock.

CAREFUL THRASHING AN IMPORTANT FACTOR.

Rice should not be thrashed until the kernel is hard and the straw throughly dry. This requires at least two weeks in the shock when the weather is dry. If the weather is rainy or the straw is wet this period may be considerably prolonged. The loss of grain in a well-constructed shock exposed to heavy rains is negligible compared to the loss that may occur when thrashing is done too soon. If the grain has cured thoroughly in the shock it should not be thrashed too early in the day. If thrashing is attempted while the straw is damp with dew there is likely to be poor separation and, of course, a loss of grain. There is danger of further loss by heating if the grain is sacked and stored while damp. When thrashing is done under contract, special attention should be given to the cleaning of the separator. This is necessary to keep varieties as pure as possible and to prevent the introduction of weeds from neighboring farms. Rough rice is greatly improved in grade by careful thrashing and too much attention can not be given to the adjustment of the concaves to prevent hulling and cracking.

WEEDY CROPS ARE LOW IN VALUE.

The conditions under which rice is grown favor the rapid and rank growth of other plants that thrive in water and wet soil. These plants may become troublesome weeds if not eradicated when they first appear in the field. If weeds are allowed to grow they may reproduce so rapidly that a large part of the field may soon become occupied by them and thus cause heavy loss by reducing the rice yield. The loss is further increased by the presence of their seeds in the rough rice, which greatly affects the value of the crop. A weedy crop never has a high market value. On account of their general hardiness and the large number of seeds which many of them are capable of producing, weeds are not easily controlled. Since the control and eradication of weeds increase the cost of production it is very important that every method be used to prevent them from getting into the field. The danger of weed introduction may be greatly reduced by sowing only seed rice

that has been thoroughly cleaned. To prevent the distribution of weeds by irrigation water and wind, all ditches and levees should be kept clean. If weeds are allowed to grow in these places they will soon be scattered to all parts of the field. The community thrashing outfit, which is often responsible for the distribution of weeds, should always be thoroughly cleaned before using.

The worst weed of the rice fields of the United States is red rice. It is well distributed throughout the rice-producing countries of the world. The seed coat of the kernel of this rice is red, a characteristic which may serve to distinguish it from the white rices. Wherever it is introduced, and this is possible only through the use of seed containing red rice, it soon takes possession of the field unless active measures are taken to eradicate it. In discussing seed rice from the standpoint of red rice only, the importance of pure seed can not be overestimated. After heading, red rice can be readily distinguished from our commercial varieties by its loose, open, slightly-drooping head, with comparatively few grains on the branches. A slight infestation of a small acreage may be easily controlled during the first year by pulling the individual plants and removing them from the field. If this is not done, the quantity of red rice the second year will be greatly increased, for the seed of this rice shatters very badly. Of course, some of it will be harvested and thrashed with the main crop, but the quantity will be proportionately small, though large enough to affect the grade. The presence of red rice always lowers the value of the crop.

Barnyard grass, known as water grass, is a common rice-field weed. It has been known and kept under control in South Carolina for more than a century. In the prairie rice regions and on the Mississippi River rice plantations this weed has never caused heavy losses, but in California it has been particularly troublesome. It is a coarse, erect, or spreading annual, varying in height from 12 to 48 inches. It is widely distributed in all cultivated regions and grows luxuriantly in fields that are irrigated. In California this weed produces a large number of seeds. On a single plant there may be as many as 40,000 seeds. It is therefore not safe to allow a single plant to go to seed, for with such reproductive powers it would soon populate a field. Within three years after the introduction of rice into this State this grass had taken complete possession of more than 2,000 acres of rice land in the Sacramento Valley, and is now present in alarming quantities on a considerable acreage, which will soon be rendered unprofitable for rice growing unless active steps are taken for its complete eradication or control.

This weed has probably been more widely distributed through the use of seed rice containing its seed than by any other means. Water from irrigation ditches upon whose banks it has been allowed to grow contributes its quota of seed. Occasionally the seed of this grass is carried from one field to another by the floods which sometimes occur during the winter.

Seed rice containing the seed of this grass should not be used. As soon as this weed appears in a field, it should be destroyed before it produces seed. On account of their large root systems, it is not practicable to pull up the plants. They should be cut below the surface of the ground to prevent new growth. Plants which have been cut at the surface have been known to develop seed several times during a

season. As soon as they have been cut the plants should be removed from the field, for if allowed to remain in moist or wet places they will continue to grow.

A rotation of crops, including a cultivated one, and summer fallowing may be employed as the best means to obtain complete eradication of this weed. Conditions should first be made favorable for the germination of the seeds that are in the soil. After germination the plants should not be allowed to produce seed. This can be effectively done by frequent cultivation. Irrigation will probably be necessary to assure germination.

No list of rice-field weeds would be complete that did not contain the large indigo, curly indigo, bull grass, alligator head, Mexican weed, and may species of sedges. The crop losses due to these weeds may be greatly reduced by using a cultivated crop in rotation with rice when such a crop can be profitably grown.

DISEASES TAKE A TOLL.

Although rice in this country is affected by four diseases, three of which are caused by fungi, very little positive information is available which will assist the grower in combating these diseases. They are present in each rice region, except California, where the crop is not affected either by diseases or by injurious insects. The fungus disease of greatest importance is known by several names, such as rice blast, blight, and rotten neck. This fungus attacks the sheath-nodes just above the stem-node, the stem where it comes to be the axis of the head, and the base of the blades of the upper leaves. The general effects of the disease are seen in the paling and drying of leaf and stem and in the poor condition of the head. When the stem is affected below the head, a large proportion of the grains are usually poorly formed. If the attack occurs at this point after the grains have developed the stem is likely to break, resulting in the loss of the head, and reduced yields. The disease is occasionally very destructive to the young plants, causing the leaves to dry and shrivel.

Preventive and remedial measures can not be recommended until more is known about the life history of the fungus. Since its greatest damage is done late in the season, the use of early-maturing rices may lessen the losses. It may be possible to develop rices that will have satisfactory resistance to the disease.

The green smut and the black smut occur so seldom that for the present they may not be considered of economic importance, yet under certain favorable conditions they might become serious diseases.

The general effect of the disease commonly referred to as "straight head" is seen in the erect and green head, which seldom sets any seed. There is evidence that the vitality of the plant is reduced by a weakened root system which may have been caused primarily by fungi or bacteria, or by faulty nutrition connected in some way with soil preparation and irrigation. The affected plant does not seem to have sufficent power to set seed, and as the seed-producing function of the plant is not exercised the plant, and particularly the head, remains green much longer than the normal plants. No specific recommendation for its control can be made.

REDUCE LOSSES FROM INSECTS.

Among the injurious insects may be mentioned several species attacking the developing grain, stem and roots of the rice plant.

The developing rice grain is often punctured by sucking insects, the most common one being the stink-bug, which also feeds on many grasses. When the grain is punctured while in the very early milk stage, it shrivels so badly that it becomes valueless. If the grain is punctured later, its milling quality may be greatly affected, and if it should escape breaking in the milling process, its value as a finished product is lowered considerably because of the discoloration made by the growth of saprophytic fungi and bacteria within the puncture. This insect is not a serious pest until the individuals become numerous. As this does not occur until late in the season, late-maturing rices are more greatly exposed to attack.

The stem of the rice plant is sometimes attacked by the larva of a moth. After boring into the stem, the larva feeds upon its interior surface. This weakens the straw and when the head emerges, after the attack, it loses its green color, becomes white, does not flower and consequently does not set seed. The damage done by this insect is never great and the infestation is usually local even in a small field of rice. As a general rule, the insect attacks only plants where the growth is thick. Rices with large stems are more subject to injury than those with small ones.

The rice water weevil, which in its larval stage is known by rice farmers as the "rice root-maggot," is the most injurious insect enemy of growing rice in the Southern States. It is known to damage the rice crop annually, but the extent to which it alone is responsible for low yields is not easily estimated. The loss, however, is large enough to make it worth while to use means for its control.

As soon as the irrigation water is applied to the rice fields, the adult weevil, which is approximately one-eighth of an inch long, appears and begins to feed on the leaves of the young rice plants. The injury done at this time is slight compared with the work of the insect in its larval stage upon the roots of the plant. The larvae feed entirely upon the roots. It is the severe pruning that they give the roots which affects production. The plant is seldom killed, but its growth may be seriously stunted by the loss of the majority of its roots. The destroyed roots are gradually replaced by new ones, however, and if the attack is not prolonged the injured plant revives, and makes a very good growth, though it is usually late in heading. The bad effects of the larval attacks are seen in the unequal growth of the plants in the field. This causes the crop to ripen unevenly, and delays harvest, which increases the risk of loss by shattering.

The most practical method of controlling this insect is to drain the fields within three weeks after the application of the irrigation water, while the larvae are still young and before they have weakened the plants too much. Drainage at this time, if the fields are kept dry for at least two weeks, will destroy the larvae in large numbers. A longer period of dry growth, especially if no rains occur, may injure the rice and a shorter period is not likely to have any effect on the insect.

RICE PRODUCTS.

Rice leaves the thrasher with the hull or husk attached. It is called rough rice and in this condition is sold to the miller. In the mills it is prepared for the market. After the removal of the hull and cuticle the kernels are polished. This process improves the commercial value of the rice, but decreases its food value.

After the rough rice has been cleaned, to remove all kinds of trash, it is conveyed to the milling stones, between which the hulls are removed. From these stones it passes over horizontal screens where the hulls and the whole and broken kernels are mechanically separated. The unbroken kernels, which is the brown rice of commerce, are now conveyed to a set of machines known as hullers, in which the outer skin, or cuticle, and much of the gluten layer of the grain, together with the germ, are removed by friction. After leaving the hullers the rice is screened to free it from the bran. It is again subjected to another scouring in a second set of hullers, or in a pearling cone. It is now ready to be polished, a process which gives the grains the pearly luster that is demanded by the general trade. In the polishing process more of the gluten layer and many layers of starch cells are rubbed off. This product is called rice polish. After polishing, the rice is screened. If it is to be coated with glucose and talc, as is generally done, it is conveyed to a revolving cylinder where the coating material is applied. The different grades of cleaned rice are afterwards separated.

The unbroken kernels of milled or cleaned rice are known as head rice. This kind of rice always commands the highest price and is sold under several grades, which vary in the different markets but are separated largely upon the brilliancy of the polish and the color and size of the kernels. The broken kernels may be sold as ordinary or broken rice, screenings, or brewers' rice. The last grade is composed of very fine particles of the kernels.

The principal feeds that are obtained from rice are bran, meal, and polish. The bran is composed of the cuticle and the embryo with varying quantities of hulls. Bran that contains no hulls, or comparatively none, is called meal. It is the most nutritious of the rice feeds and when fresh is very palatable to domestic animals. On account of its high percentage of fat it often becomes rancid if kept too long. In polish, the percentage of fat and protein is much lower than in meal, while the percentage of starch is much higher. Polish is used for feeding cattle and pigs.

RICE SHOULD HAVE A MORE IMPORTANT PLACE IN THE DIET.

The small amount of rice used in this country, when compared with many foreign countries, already has been referred to. Our average per capita consumption of 6 pounds per year is smaller in quantity than that consumed in many European countries where rice is not even produced. In some of the Southern States it is used at least with one meal daily. In these States it holds the same place in the dietary that the potato does in the Northern States.

Where the potato is used to supply the greater part of the starch which food must furnish daily, rice may never become the common dish of the household, although it is valuable chiefly for its starch. Among the starchy food products such as the breakfast cereals, potatoes, hominy and macaroni, it has an important place and may be

used in the same general way to contribute to the food needs of the family. It is highly nutritious, quickly cooked and easily digested and assimilated. On account of the latter qualities, well-cooked rice is often prescribed for convalescents and for persons with weak digestion.

Rice as sold by our grocers is a pretty grain with a smooth and shiny surface, attractive to the eye, but lacks the palatableness that makes foods popular. This rice has been so highly milled that it has been robbed of much of its food value and of most of its oily flavoring matter, leaving a product known to the trade as polished rice, which to many persons, is tasteless. If the American housewife could be induced to demand brown rice instead of taking the polished product, there would be a marked increased consumption of this cereal in a very short time, due in part if not entirely to the pleasing flavor of the kernel.

Unpolished rice is offered and accepted as a product superior to the polished rice, but in reality its food value is only better by so small a degree that it is practically negligible. In the preparation of the polished and the unpolished rice, the cuticle, aleurone layer, and germ, which contains much protein and other important food constituents, are removed, reducing greatly the nutritive value of the grain. The real difference between these two mill products is largely in the coating of the polished rice with glucose and talc, and the absence of a coating material on the unpolished.

The superiority of the brown rice over either of these lies in the fact that the entire seed as nature produced it is used, except the enclosing husks or hulls which have been removed.

No food, regardless of its merits, will appeal to the consumer unless it can be made into an attractive dish. In this country rice comes to the table as an uninviting, glutinous mass, except in certain sections of the Southern States where it is served with each grain distinct and separate, making a very tempting and appetizing dish. A platter heaped with loose, flaky kernels of rice is not only pleasing to the eye, but satisfying to the appetite. It is very probable that the attractive appearance of this dish on the South Carolina table has had much to do with the popularity and usefulness of rice in that State.

In seeking information on the art of cooking rice, no mistake is made in referring to South Carolina, where the true value of this cereal has been appreciated for over two centuries. A Carolina housewife would advise the using of 1 pint of rice, after thorough washing, which she considers important, "to a quart and a pint of water," and a teaspoonful of common salt. "This is to be boiled over a quick fire for ten minutes, stirring occasionally. Then pour off all or nearly all the water; cover the vessel and put over a very slow fire, and allow it to steam for fifteen minutes at least, stirring occasionally. The rice will be soft or grainy, according to the quantity of water left on it when put to steam, and the length of time allowed in the steaming. The larger the quantity of water and the shorter the steaming, the softer will be the rice."

Of course, other methods are used in boiling rice or at least modifications of the recipe given, but it must be remembered that the results should not be a glutinous mass and that success depends upon the proper amount of water used and the length of time in steaming.